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ABSTRACT

Competencies for production machine shop are provided for the second of four topic areas: saws, drills, and grinders. Each competency appears in a one-page format. It is presented as a goal statement followed by one or more "indicator" statements, which are performance objectives describing an ability that, upon attainment, will establish competency for the stated goal. Indicator statements are further qualified by one or more "benchmark" statements or observable behaviors describing what the trainee will do to prove that he/she is demonstrating achievement of the performance objective. Benchmark statements are followed by an "assessment" statement, which describes how the observer determines that the benchmark is achieved and establishes the criteria for performance. The competencies for this topic are divided into eight sections: twist drill, workholding devices, drilling machines, drill press, reaming on the drill press, sawing machines, abrasives, and grinding machines. (YLB)

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Production Machine Shop Employment Competencies Part Two: Saws, Drills, and Grinders

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Los Angeles Unified School District
Manpower Program Development

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PREFACE

The competencies for Production Machine Shop have been developed in four topic areas as follows:

1) Part One: Principles and Practice of Machine Shop
2) Part Two: Saws, Drills, and Grinders
3) Part Three: The Engine Lathe
4) Part Four: The Milling Machine

Each topic has a number of competencies identified. The competencies are presented as a series of goal statements followed by one or more "indicator" statements. An "indicator" is a performance objective describing an ability, which, upon attainment, will establish competency for the stated goal.

Indicator statements are further qualified by a series of "benchmark" statements. A "benchmark" is an observable behavior. Benchmarks describe what the trainee will do to prove that he is demonstrating achievement of the performance objective. Benchmarks are an end result, they do not describe how the trainee learned the behavior, they only state what the behavior is. There may be one or more benchmarks (behaviors) for each indicator statement (performance objective). Benchmark statements are followed by an "assessment" statement. The assessment statement describes how the observer determines that the benchmark is achieved. Assessment statements establish the criteria for performance. Instructor, class member consensus opinion, or combination of instructor input and trainee input may contribute to the final determination of evaluation criteria. The assessments that are shown provide the basis for performance evaluation for each benchmark.

USE OF THE COMPETENCIES

The integrati n of the material into course curriculums is dependent on the agency p-oviding JTPA training services. Selection of competencies should be based on participant need and compatibility with the course of instruction. The identification of Production Machine Shop Competencies does not attempt to provide input in regards to teaching methodology. The statements present a consensus opinion of optimum skill level for youth entering the work force in the area of Production Machine Shop.

VALIDATION

The competencies were developed from research and direct experience in the instruction of JTPA participants. Validation of the attached material was achieved through a consensus of instructional staff and employer Advisory Boards. Their collective opinion was formed from research and data, which provided the basis for the selection of Production Machine Shop Competencies.

ACKNOWLEDGEMENTS

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Grateful acknowledgement is made of Lucinda Stites, Word Processing Instructor, and her crew of student word processors who have assisted during the productior of materials.

The technical information provided in the attached material has been developed form the course text, General Industrial Machine Shop by Harold V. Johhson, Chas. A. Bennett Co., Inc., Peoria, Ill.

Competencies have been written by Gus Bishart with the assistance of Claire Werner as part of the school district's contract with the City of Los Angeles and the State of California.

Bernardo R. Sandoval, Director
Manpower Program Development
December, 1984

SECTION ONE

TWIST DRILL

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates knowledge of drill types and the basic function of a twist drill.

BENCHMARK: The trainee identifies a twist drill, names its parts, and describes the basic function of each part.

ASSESSMENT: The trainee identifies a twist drill and provides the following information:

1. The Point: The point is the entire cone-shaped end that forms the cutting edge of the drill. The point includes the cutting edge, formed by the flute.

   a. The "dead center" is at the extreme tip end of the drill.
   b. The "lips", or "cutting lips" are the cutting edges of the drill. The lips must be of equal length and have the same angle. This is needed so that the drill will run true and not cut a hole larger than the tool itself.
   c. "Lip clearance", or lip relief, is the slope ground on the point of the drill extending from the cutting lip back to the heel. Lip clearance allows the cutting edges of the drill to enter into the workpiece without interference.

2. The Body: The "body" is the portion of the drill between the point and the shank. It consists of the following parts:

   a. The two spiral grooves that run along the body of the drill are known as "flutes'. The flutes do four things:
      1) Help from the proper cutting edges on the cone-shaped point.
      2) At their junction with the cutting edges, they curl the chip tightly within itself.

CONTINUED ON NEXT PAGE

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates knowledge of drill types and the basic function of a twist drill.

BENCHMARK: CONTINUED

ASSESSMENT: CONTINUED

3) They form channels to permit the chips to escape from the hole.
4) They allow lubricant to reach the cutting edges.

b. The "margin" is a small narrow strip on the tip of the drill. It reduces the friction between the drill body and the hole.

c. The "web" is the metal column that separates the flutes.

3. The Shank: Is the end of the drill that fits into the socket, spindle, or chuck of the drilling machine.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates knowledge of drill types and the basic function of a twist drill.

BENCHMARK: The trainee identifies various types of drills.

ASSESSMENT: Given pictures or actual tools, the trainee identifies no less than five drill types from the following group:

1. Chipbreaker Drill
2. Fluted Core Drill
3. Coolant-Feeding Drill
4. Gun Drill
5. Subland Drill
6. Step Drill
7. Spiral-Point Drill
8. Split-Point Drill

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates knowledge of drill types and the basic function of a twist drill.

BENCHMARK: The trainee performs at least one drill point grinding operation by hand.

ASSESSMENT: The trainee proceeds as follows:

1. Dresses and trues up the grinding wheel.
2. Checks the drill to see if it is dull or the margins located near the point are worn.
3. Grasps the drill near the point, in the right hand, with the left hand holding the shank.
4. Holds the lip of the drill at an angle of 59° to the grinding wheel.
5. Moves the hand, holding the shank downward. Does not twist the drill. Keeps the end of the shank below the level of the cutting lip. Keeps the clearance behind the cutting edge at about 12°.
6. Grinds the other lip in the same manner.
7. Checks the drill point with a drill-grinding gage. Checks to make sure that the cutting edges are the same length and at the same angle with the axis-59°. Makes sure that the lips are ground with equal angles and equal lengths.

SECTION TWO

WORKHOLDING DEVICES

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates an understanding of various workholding devices.

BENCHMARK: The trainee states the primary safety rule to remember when using a drill.

ASSESSMENT: The trainee states the following:

Never hold a workpiece on the drilling machine table using only your hand.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates an understanding of various workholding devices.

BENCHMARK: The trainee identifies various tools used to hold work on the drilling machine.

ASSESSMENT: Given a set of pictures or actual tools, the trainee identifies no less than five holding devices.

SECTION THREE

DRILLING MACHINES

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee recognizes various types of drilling machines.

BENCHMARK: The trainee provides the names for various types of drilling machines.

ASSESSMENT: Given a set of pictures of drilling machines, the trainee names no less than four machine types from the following group:

1. Portable Drills
2. The Drill Press
3. Gang Drilling Machine
4. Multiple-Spindle Drilling Machine
5. Turret Drilling Machine
6. Radial Drilling Machine
7. Gun Drilling Machine
8. Transfer-type Drilling Machine
9. Boring Machine

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee recognizes various types of drilling machines.

BENCHMARK: The trainee identifies and names the parts on a drill press.

ASSESSMENT: The trainee identifies and names the following parts:

1. Motor
2. Spindle Speed
3. Depth Gage
4. Feed Lever
5. Spindle
6. Table
7. Column
8. Base

SECTION FOUR

USING A DRILL PRESS

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to use a drilling machine.

BENCHMARK: The trainee states at least one cause for common drill problems.

ASSESSMENT: Having studied the following chart, the trainee is able to provide at least one reason for common drilling troubles.

Instructor's approval indicates satisfactory completion.

Common Drill Troubles and Causes

Indications	Causes
Outer corners break down.	Cutting speed too high. Hard spots in material. No cutting compound at drill point. Flutes clogged with chips.
Cutting edges chip.	Too much feed. Lip clearance too great.
Checks or cracks in cutting edges.	Overheated or too quickly cooled while sharpening or drilling.
Margin chips.	Oversize jig bushing.
Drill breaks.	Point improperly ground. Feed too heavy. Spring or back lash in drill press, fixture, or work. Drill is dull. Flutes clogged with chips.
Tang breaks.	Imperfect fit between taper shank and socket caused by dirt or chips, or burred or badly worn sockets.

CONTINUED ON NEXT PAGE

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to use a drilling machine.

BENCHMARK: CONTINUED

ASSESSMENT: CONTINUED

Indications	Causes
Drill breaks when drilling brass or wood.	Flutes clogged with chips. Improper type drill.
Drill splits up center.	Lip clearance too small. Too much feed.
Drill will not enter work.	Drill is dull. Lip clearance too small. Too heavy a web.
Hole rough.	Point improperly ground or dull. No cutting compound at drill point. Improper cutting compound. Feed too great. Fixture not rigid.
Hole oversize.	Unequal angle or length of the cutting edges-or both. Loose spindle.
Chip shape changes while drilling.	Drill becomes dull or cutting edges chipped.
Large chip coming out of one flute, small chip out of other flute.	Point improperly ground, one lip doing all the cutting.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to use a drilling machine.

BENCHMARK:

1. The trainee explains the meaning of elements used in the formula to compute the RPM at which to run the drilling machine for a given cutting speed.

2. The trainee calculates the RPM to run the drilling machine for no less than three different cutting speeds.

ASSESSMENT: The trainee provides the following information:

1. SFPM = Surface Feet Per Minute

   RPM = Revolutions Per Minute

2. The trainee computes problems demonstrating the correct use of the following formula:

$$RPM = 3.8 \times \frac{SFPM}{\text{drill diameter in inches}}$$

SFPM = .26 RPM X drill diameter in inches

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to use a drilling machine.

BENCHMARK: The trainee demonstrates the ability to use and interpret a Drill Speed Chart correctly.

ASSESSMENT: When working on the drill press, the trainee uses the following chart correctly to assist him/her in determining an appropriate drill speed.

Drill Speeds

Material	m/min		ft/min	
	HSS	Carbide	HSS	Carbide
Aluminum and aluminum alloys	45- 90	70-135	150-300	230-450
Brass and bronze (free cutting)	45- 90	70-133	150-300	230-450
Brass and bronze (high tensile)	20- 35	35- 90	70-120	120-200
Cast iron (soft)	25- 35	40- 90	80-120	130-200
Cast iron (medium)	18- 27	30- 45	60- 90	100-150
Cast iron (hard)	10- 20	15- 40	30- 70	50-130
Copper	20- 30	35- 50	70-100	120-170
Magnesium	60-120	90-180	200-400	300-600
Nickel-base alloys	6- 15	12- 27	20- 50	40- 90
Plastic and related materials	30- 60	45- 90	100-200	150-300
Steel				
Alloyed-under 200 B.H.	18- 27	30-45	60- 90	100-150
Alloyed-200-300 B.H.	12- 20	20- 40	40- 70	70-130
Alloyed-over 300 B.H.	6- 9	12- 18	20- 30	40- 60
Cast and forged	12- 20	20- 40	40- 70	70-130
Heat treated-35-40 R.C.	10- 12	18- 25	30- 40	60- 80
Heat treated-40-45 R.C.	6- 10	12- 18	20- 30	40- 60
Heat treated-over 45 R.C.	3- 6	6- 12	10- 20	20- 40
Mild-.2-.3 carbon	20- 30	36- 50	70-100	120-170
Mild-.4-.5 carbon	15- 24	27- 45	50- 80	90-150
Stainless-300 Series	6- 15	12- 27	20- 50	40- 90
Stainless-400 Series	10- 20	15- 20	30- 70	50-130
Tool-over 1.0 carbon	12- 18	20- 33	40- 60	70-110
Titanium alloys	6- 15	12- 27	20- 50	40- 90
Wood	60- 90	90-135	200-300	300-450

Note: In this table, B.H. stands for the Brinell hardness rating; R.C. stands for the Rockwell test rating.

Instructor's approval indicates satisfactory completion.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to use a drilling machine.

BENCHMARK: The trainee defines the term "drill feed".

ASSESSMENT: The trainee states that the "drill feed" is the distance the drill advances into the workpiece for each revolution.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to use a drilling machine.

BENCHMARK: The trainee uses a Drill Feed Chart effectively.

ASSESSMENT: The trainee utilizes the following chart correctly to determine the drill feed when working on common materials.

Drill Feeds

Diameter Range		Normal Feed		Heavy Feed	
mm	in	mm	in	mm	in
1.6-3.2 mm	1/16"-1/8"	0.02-0.05	0.001-0.002	0.05-0.10	0.002-0.004
3.2-6.4 mm	1/8"-1/4"	0.05-0.10	0.002-0.004	0.10-0.20	0.004-0.008
6.4-12.7 mm	1/4"-1/2"	0.10-0.20	0.004-0.008	0.20-0.40	0.008-0.016
12.7-25.4 mm	1/2"-1"	0.20-0.40	0.008-0.016	0.40-0.60	0.016-0.024
over 25.4 mm	over 1"	0.40-0.60	0.016-0.024	0.60-0.80	0.024-0.032

Instructor's approval indicates satisfactory completion.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to use a drilling machine.

BENCHMARK: The trainee identifies the three major steps required for laying out a workpiece for a drilling operation.

ASSESSMENT: The trainee states the following:

1. Blueprint interpretation.
2. Preparation of the workpiece.
3. Knowledge and use of proper layout and measuring tools.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to use a drilling machine.

BENCHMARK: The trainee follows the correct procedure for laying out a workpiece which is to be drilled.

ASSESSMENT: The trainee proceeds as follows:

1. Coats the workpiece with layout dye.
2. Draws two lines at right angles in the proper location.
3. Uses prick and center punch to make indentation at the intersection of two lines.
4. With a divider, scribes a circle the same size as the hole to be drilled. Scribes a "proof" circle inside the first circle.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to use a drilling machine.

BENCHMARK: The trainee performs at least one drilling operation on the drill press.

ASSESSMENT: The trainee proceeds as follows:

1. Selects the proper drill.
2. If a straight-shank drill is used, mounts the drill in a drill chuck. If a taper-shank drill is used, inserts it directly in the spindle, or in a drill sleeve and then in the spindle.
3. Turns on the power to see if the drill is running straight.
4. Adjusts the machine for the correct speed.
5. Mounts the workpiece in a vise or clamps it to the table.
6. Moves the point of the drill with the handfeed lever. Lines up the point with the punch mark on the workpiece. Checks to see that the depth of cut will be correct.
7. Turns on the power. Feeds the drill into the workpiece to enlarge the punch mark. Applies cutting fluid and begins drilling.
8. Checks to see if the circle cut by the drill is true with the proof circle.
9. Applies even pressure.
10. Raises the drill occasionally to clear the hole of chips. Applies adequate cutting fluid. As the drill begins to break through the lower side of the workpiece, releases the pressure slightly.
11. Raises the drill from the work. Turns off the power.

Instructor's approval indicates satisfactory completion.

SECTION FIVE

REAMING ON THE DRILL PRESS

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to ream on a drilling machine.

BENCHMARK: The trainee performs no less than one reaming operation on the drill press.

ASSESSMENT: The trainee proceeds as follows:

1. Selects a reamer and mounts it on the drilling machine in one of the following ways:
   a. Directly in the spindle, provided the reamer has a taper shank.
   b. With the use of drill sleeves or sockets.
   c. With the use of drill chucks.
2. Drills the hole 0.4 mm (1/64") undersize, for holes up to 12.7 mm (1/2") in diameter. For holes over this diameter, drills 0.8 mm (1/32") undersize.
3. Inserts the reamer in the chuck or taper shank spindle.
4. Reduces the speed of the machine.
5. Checks to see that the reamer is lined up with the hole.
6. Feeds slowly into the hole, applying a cutting oil generously.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to ream on a drilling machine.

BENCHMARK: The trainee identifies five steps that will control "chattering" during reaming.

ASSESSMENT: The trainee states the following:

1. Selecting the correct reamer.
2. Mounting the workpiece correctly.
3. Correct feeding.
4. Proper lubricant.
5. Checking reamer for rough-cutting lands.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop drills to produce cylindrical holes.

INDICATOR: The trainee demonstrates the ability to ream on a drilling machine.

BENCHMARK: The trainee names five outcomes which may result from using a good lubricant during drilling or reaming.

ASSESSMENT: The trainee states the following:

1. Greatly reduces friction between the tool and workpiece.
2. Carries away heat and reduces friction.
3. Lubricates the chips. Aids in chip clearance.
4. Forces chips back from the cutting edges and out the flute of oil-feeding drills.
5. Improves the finish of the work.

SECTION SIX

SAWING MACHINES

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee names the three classifications of sawing machines.

ASSESSMENT: The trainee states the following:

1. Reciprocating (power hacksaw).
2. Band Saw (horizontal, vertical cut off, and friction).
3. Circular Saw (cold saw, steel friction disc, and abrasive disc).

Information in parentheses is optional.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee identifies the power hacksaw and names the basic parts.

ASSESSMENT: The trainee correctly identifies the power hacksaw and points to and names the various parts of the machine. Instructor's approval indicates satisfactory completion.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee identifies four types of work set-ups used on the power hacksaw.

ASSESSMENT: The trainee states the following:

1. Thin strips should be laid flat.
2. Short ends of stock should be cut singly to assure firm clamping and accurate dimensions.
3. Round stock or tubing, when gang cut, should be held tight by clamps or chain vise.
4. Round stock or tubing can be cut two bars at a time by attaching a tapered wedge- thick end up- to both jaws.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee identifies general principles which should be observed when selecting a blade for use on a power hacksaw.

ASSESSMENT: The trainee states the following:

1. At all times, at least two teeth should be engaged in the material to be cut.
2. Large sections require coarse teeth to provide ample chip clearance.
3. Small or thin-wall sections require fine teeth.
4. Soft, easily machined metals require slightly coarser teeth to provide chip clearance.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee identifies three general principles which should be considered when determining the correct feeds for a particular power hack saw job.

ASSESSMENT: The trainee states the following:

1. Moderate feed pressures must be used when straight, accurate cutting is desired.

2. Excessive feed pressures cause the machine to vibrate or chatter.

3. A free-cut, curled chip indicates ideal feed pressure for fastest cutting with longest blade life. Coolant is recommended when sawing ferrous metals (except cast iron). Coolant is recommended for most nonferrous metals.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee demonstrates the ability to use a "Selection Chart for Blade and Feed of Power Hacksaws".

ASSESSMENT: Given questions regarding the feed pressure and blade used for various types of cutting jobs, the trainee refers to the following chart and identifies the most appropriate blade and feeds.

Selection Chart for Blade and Feed of Power Hacksaw

Type of Cutting	Feed Pressure	Width of Blade	Thickness of Blade
Light angle iron, pipe, rods	Light to moderate	25.4 mm [1"]	1.2 mm [0.050"]
General purpose cutting	Moderate	31.8 to 38 mm [1¼" to 1½"]	1.5 to 1.9 mm [0.062" to 0.075"]
Large Sections	Heavy	44.4 to 50.8 mm [1 3/4" to 2"]	2.2 to 2.5 mm [0.088" to 0.100"]

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee distinguishes between three saw blades and identifies by name each blade type.

ASSESSMENT: Given pictures of blade sets, or actual saw blades, the trainee identifies the following:

1. Straight set.
2. Raker set.
3. Wave set.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee identifies the three general classifications of band saws.

ASSESSMENT: The trainee states the following:

1. Horizontal machines for cut-off sawing.
2. Vertical machines for straight or profile sawing at conventional speeds.
3. Vertical machines for nonferrous cutting and/or friction cutting.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee identifies and names the parts on a standard duty vertical band sawing machine.

ASSESSMENT: The trainee identifies and names the following parts:

1. Job Selector
2. Hydraulic Worktable
3. Feed Handwheel
4. Table Tilt Lock Handwheel
5. Hydraulic Oil Reservoir
6. Foot Control for Table
7. Variable Speed Control
8. Gearshift Lever
9. Operating Control Panel
10. Welder
11. Blade Shear
12. Flash Grinder

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee uses a chart to determine common causes of blade failure and their corrections.

ASSESSMENT: Given examples of blade failure, the trainee refers to the following chart and identifies the correction. Instructor's approval indicates satisfactory completion.

Common Causes of Blade Failure and Their Corrections

Type of Failure	Causes	Correction
Rounded Teeth or Premature Wear	Feed too light.	Use a feed heavy enough to generate fully curled chips.
	Too much speed.	Reduce the speed of the blades.
	Too much weight or feed.	Reduce until discolored chips disappear.
	Wrong pitch for material being cut.	Use blade with number of teeth specified for that material.
	Blade not raising on return stroke.	Check the machine. Repair if not raising blade on noncutting stroke.
Teeth Ripping	Improper pitch being used. Feed too heavy.	Use proper pitch for material being cut. Reduce feed.
Breaking of the Blade at Pinhole	Blade drawn too tight in frame.	Reduce tension on blade to just enough to hold it straight and prevent twisting or buckling with a straight, steady stroke.
	Blade twisting when cutting.	
Blades Cutting Crooked	Blade rubbing on vise or other clamping devices.	Readjust clamping.

CONTINUED ON NEXT PAGE

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: CONTINUED

ASSESSMENT: CONTINUED

Type of Failure	Causes	Correction
Blades Cutting Crooked	Frame holding blade badly worn in slide.	Check adjustment of machine. Make repairs if necessary.
	Frame out of line with vise.	
	Blade loose in frame.	Make proper adjustment.
	Stock not tight and square in vise.	Inspect clamps. Remove any chips that may be between jaws.
	Feed too heavy.	Reduce.
	Blade worn out.	Change blade.
Blades Snapping and Breaking	Dropping blade on stock at start of cut.	Start feed just above stock.
	Insufficient or too much tension on the blade.	Make proper adjustment.
	Material cut jams against blade at finish of cut.	Unavoidable unless stock gauge is removed, or material clamped outside vise.
	Teeth too coarse for stock being cut.	Use correct pitch.
	Starting new blade in cut unfinished by worn out blade.	Start new cut.
	Too heavy pressure.	Use lighter feed.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee correctly uses a chart to determine the approximate speeds for band sawing common metals.

ASSESSMENT: Given examples of metals to be sawed, the trainee refers to the following chart and correctly identifies the appropriate speed. Instructor's approval indicates satisfactory completion.

Recommended Approximate Speeds for Band Sawing Common Metals

		Carbon-Steel Blades		High-Speed Steel Blades	
AISI Type	Description	m/min	FPM	m/min	FPM
Easily Machinable					
1010-1035	Straight-carbon steels	45-53	150-175	90	300
1040-1050	Medium-carbon steels	30-45	100-150	60	200
1100-1130	Free-cutting low-carbon steels	45-53	150-175	90	300
1137-1150	Free-cutting medium-carbon steels	30-45	100-150	76	250
Moderately Difficult to Machine					
1065-1095	High-carbon steels	24-38	80-125	45	150
1320-1345	Manganese steels	20-38	70-125	60	200
2317-2517	Nickel steels	22-30	75-100	53	175
3115-3315	Nickel-chrome steels	15-30	50-100	60	200
4017-4068	Moly steels	22-41	75-135	60	200
4130-4150	Chrome-moly steels	15-30	50-100	68	225
4317-4340	Nickel-chrome moly steels	15-30	50-100	60	200
4608-4820	Nickel-moly steels	15-30	50-100	60	200
Nonferrous					
	Aluminum bronze	213	700		
	Beryllium copper	243- 609	800-2000		
	Manganese bronze	61- 275	200- 900		
	Phosphor bronze	91- 213	300- 700		
	Silicon bronze	61- 275	200- 900		
	Aluminum castings and forgings	91- 457	300-1500		
	Aluminum extrusions	609- 914	2000-3000		
	Aluminum sheet	914-1524	3000-5000		
	Copper, brass	457	1500		
	Babbit, lead	457-914	1500-3000		

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has the ability to use Machine Shop power saws.

INDICATOR: The trainee demonstrates the ability to correctly use a sawing machine.

BENCHMARK: The trainee performs no less than one contour sawing operation on the vertical band saw.

ASSESSMENT: The trainee proceeds as follows:

1. Draws guide lines on the workpiece unless a machine guide is used.
2. Selects the proper blade for the job.
3. Consults the job selector chart to determine the correct cutting speed.
4. Lowers the saw guide until it is about 13 mm (1/2") above the thickest part of the workpiece. Clamps the saw guide in position.
5. Starts the saw and beings the workpiece up to the blade. Then advances the workpiece against the blade with steady pressure.
6. If round stock or irregular workpieces are cut, the trainee secures them in a clamp.
7. If internal cutting is done, drills starting holes in the workpiece. Threads the saw blade through one of the holes. Welds the blade on the butt welder into an endless band. Makes the cut.

SECTION SEVEN

ABRASIVES

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demonstrates an understanding of the function and use of abrasives on grinding machines.

BENCHMARK: The trainee defines the term "abrasive".

ASSESSMENT: The trainee states the following:

An abrasive can be defined as any hard, sharp material that wears away another material when moved in pressure contact.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demonstrates an understanding of the function and use of abrasives on grinding machines.

BENCHMARK: The trainee identifies the two factors which determine the ability of a mineral grain or particle to penetrate the material being ground.

ASSESSMENT: The trainee states the following:

1. The hardness and shape of the abrasive.
2. The ability of the abrasive to resist breakdown under the stresses of the grinding operation.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demonstrates an understanding of the function and use of abrasives on grinding machines.

BENCHMARK: The trainee identifies the two components which characterize a grinding wheel. The trainee recognizes that grinding wheels are manufactured in various sizes and grades to suit many purposes.

ASSESSMENT: The trainee states the following:

1. The abrasive grains.
2. The bond that cements the grains together.
3. States that there are several types and sizes of grinding wheels, also known as an "abrasive wheel".

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demonstrates an understanding of the function and use of abrasives on grinding machines.

BENCHMARK: The trainee identifies three grinding wheel functions which are basic to all grinding operations.

ASSESSMENT: The trainee states the following:

1. To generate size.
2. To generate surface.
3. To remove stock.

COMPETENCY [illegible]: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

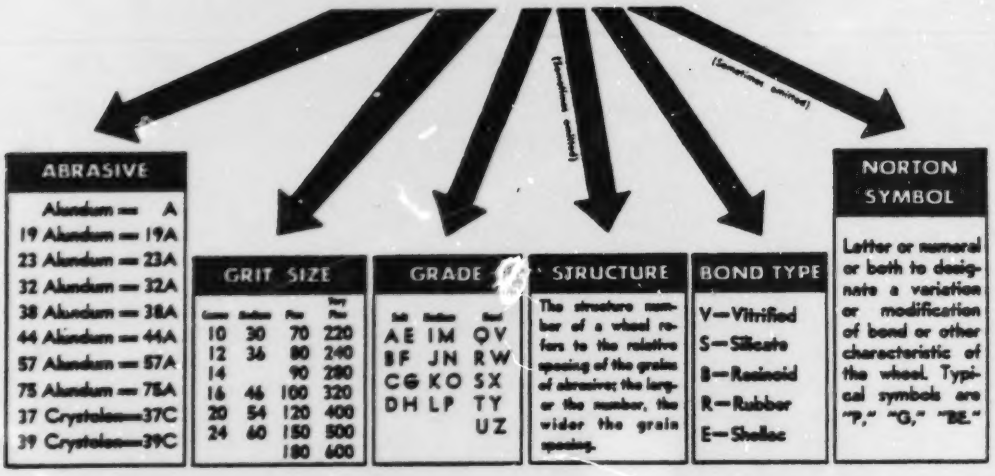
INDICATOR: The trainee demonstrates an understanding of the function and use of abrasives on grinding machines.

BENCHMARK: The trainee uses the Norton Grinding Wheel Marking Chart to determine the characteristics of selected grinding wheels.

ASSESSMENT: Given several grinding wheels, the trainee checks the markings on the wheel and compares them to the following chart. The trainee identifies qualities of the abrasive wheel. Instructor's approval indicates successful completion.

NORTON GRINDING WHEEL MARKING

32A46-H8VBE



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COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demcnstrates an understanding of the function and use of abrasives on grinding machines.

BENCHMARK: The trainee mounts the grinding wheel observing rules which prevent the wheel from breakage.

ASSESSMENT: The trainee observes the following precautions:

1. Before mounting, the trainee tests the wheel for damage.
2. Does not mount a wheel without using washers or some compressible material.
3. Does not force wheels on the mounting.
4. Takes care in tightening the nut against the flange.
5. Uses a diamond dressing tool to sharpen the wheel.

Instructor's approval indicates successful completion.

SECTION EIGHT

GRINDING MACHINES

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demonstrates the ability to correctly use a grinding machine.

BENCHMARK: The trainee identifies two types of grinding machines used in the shop.

ASSESSMENT: The trainee identifies the following:

1. Face Grinder.

2. Universal Grinder Machine.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demonstrates the ability to correctly use a grinding machine.

BENCHMARK: The trainee defines "trueing" and "dressing" a grinding wheel.

ASSESSMENT: The trainee states the following:

1. Trueing - a grinding wheel to its original shape means removing all the high spots.

2. Dressing - The wheel may be defined as the process of removing material from the entire surface of the wheel. This is done to restore the cutting properties.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demonstrates the ability to correctly use a grinding machine.

BENCHMARK: The trainee correctly computes the appropriate speed of the grinding wheel.

ASSESSMENT: The trainee calculates the RPM and surface speed per minute using the following formula:

$$\text{RPM} = \frac{12 \times \text{surface speed}}{3.1416'' \times \text{wheel diameter}}$$

$$\text{Surface Speed} = \frac{3.1416'' \times \text{wheel diameter} \times \text{RPM}}{12}$$

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demonstrates the ability to correctly use a grinding machine.

BENCHMARK: The trainee performs no less than one surface grinding operation on the grinding machine.

ASSESSMENT: The trainee proceeds as follows:

1. Mounts the workpiece on a magnetic chuck.
2. Sets table reverse dogs so that center of workpiece clears approximately 25.4 mm (1").
3. Sets cross-feed the proper amount.
4. Moves the workpiece under the wheel. Leaves about 3.2 mm (1/8") between the workpiece and wheel.
5. Turns on the grinder. Lowers the wheel until the wheel just sparks the workpiece.
6. Throws in the automatic feed. Feeds the entire width of the workpiece under the wheel to check for high spots.
7. Continues the grinding operation by lowering the wheel for every cut until the operation is completed.
8. Shuts off the machine and releases the magnet.

Instructor's approval indicates satisfactory completion.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demonstrates the ability to correctly use a grinding machine.

BENCHMARK: The trainee performs no less than one cylindrical grinding operation on the grinding wheel.

ASSESSMENT: The trainee proceeds as follows:

1. Starts grinding wheel to warm up spindle bearings.
2. Dresses the wheel with proper diamond dresser.
3. Cleans workpiece centers and machine centers. Checks to make sure machine centers are in good shape with all nicks eliminated.
4. Aligns headstock and footstock centers.
5. Sets up the headstock and footstock to the proper length of the work so that the workpiece center will be over the center of the table.
6. Tightens the dog on the workpiece end. Engages drive plate pin in the dog fork.
7. Adjusts table dogs for an overrun on each end approximately one-third of wheel width.
8. Sets grinder for the proper wheel speed. Sets the work speed for the diameter and type of material to be ground. The headstock spindle should rotate the workpiece in a direction opposite to that of the grinding wheel.
9. Sets the automatic infeed for each table reverse. Sets the dwell time that permits the wheel to clear the workpiece at each end of the stroke.
10. Sets the desired table traverse. The table traverse should be such that the table will move one-half of the wheel width per revolution of the workpiece.

CONTINUED ON NEXT PAGE

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demonstrates the ability to correctly use a grinding machine.

BENCHMARK: CONTINUED

ASSESSMENT: CONTINUED

11. Starts the table movement. Moves the wheel towards the workpiece until sparking starts.

12. Throws in the wheel-feed clutch lever and starts the grinding process. Checks the workpiece for a taper after first pass. The trainee adjusts as necessary.

13. Stops the machine. Checks the diameter of the workpiece with a micrometer to determine the amount of material to be removed. Sets the infeed index for this amount.

14. Grinds the workpiece to size and checks diameter for proper dimensions. If necessary, corrects index setting. Finishes to size.

Instructor's approval indicates satisfactory completion.

COMPETENCY AREA: PRODUCTION MACHINE SHOP

COMPETENCY STATEMENT: The trainee has an understanding of grinding procedures and the function and use of grinding machines.

INDICATOR: The trainee demonstrates the ability to correctly use a grinding machine.

BENCHMARK: The trainee completes no less than one tool grinding operation on the grinding machine.

ASSESSMENT: During the completion of assigned projects, the trainee demonstrates the ability to grind tools as required on the grinding machine. Instructor's approval indicates satisfactory completion.